PC BASED SMPS PROTECTION

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Date : ……

Dedicated to my beloved parents,

Md Isa Bin Rejab and Surni Binti Kerya

Sisters and brother,

Anis Farhah, Suhana and Sofuan

For giving a constant source of support and encouragement

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ABSTRACT

The PC Based SMPS Protection is a system that preventing the electrical equipment from damage due to overvoltage and overcurrent. This project is able to replace the function of fuse, increase efficiency of protection and reduce maintenance cost. This project basically focus on the designing the system include sensing elements, amplifier circuit and software (VB.net). When overvoltage or overcurent occurred the system is automatically turn-off the supply to the load by disable the PWM signal to the SMPS. In addition, the warning message is activated due to this problem to alerts the user from the problem occurred. Thus, the load or electrical components are safe from damage of overvoltage and overcurrent. The system detects the overvoltage and overcurrent from sensing circuit that using the shunt resistor concepts. The system used DAQ (USB-4716) as the data acquisition to convert the analogue to digital data (ADC) for data logging and integrated with the VB.net programming language to communicate with user. Through PC, user can monitor the status of the current and voltage to the load or electrical components.

ABSTRAK

PC Based SMPS Protection adalah sebuah sistem pencegahan peralatan elektrik daripada kerosakan disebabkan oleh voltan lampau dan arus lebih. Projek ini berupaya menggantikan fungsi fius, menambah kecekapan perlindungan dan mengurangkan perbelanjaan tanggungan. Projek ini pada asasnya menumpukan kepada mereka sistem perlindungan termasuk litar penderiaan, litar amplifier dan perisian komputer. Apabila voltan lampau atau arus berlebihan berlaku, sistem ini akan menutup bekalan secara automatik kepada muatan dengan menghentikan isyarat PWM kepada SMPS. Tambahan pula, mesej amaran akan diaktifkan untuk memberi amaran kepada pengguna disebabkan masalah yang berlaku terhadap muatan. Oleh itu, muatan atau komponen-komponen elektrik akan selamat daripada kerosakan voltan lampau dan arus lebih. Sistem ini mengesan voltan lampau dan arus lebih daripada litar penderiaan menggunakan konsep perintang berselari. Sistem ini menggunakan DAQ (USB 4716) sebagai pemerolehan data untuk menukar isyarat analog kepada data digital (ADC) untuk pengelogan data dan disepadukan dengan bahasa pengaturcaraan VB.net untuk berkomunikasi dengan pengguna. Melalui PC, pengguna dapat mengetahui status arus dan voltan kepada muatan atau komponen-komponen elektrik yang digunakan.

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LIST OF ABBREVIATION

V	-	Voltage
I	-	Current
AC	-	Alternating Current
DC	-	Direct Current
Ω	-	Ohm
Vin	-	Input Voltage
Vo	-	Output Voltage
Rs	-	Sensing Resistor
Rl	-	Load Resistor
SMPS	-	Switch Mode Power Supply
PWM	-	Pulse Width Modulation
DAQ	-	Data Acquisition
GUI	-	Graphical User Interface
DAC	-	Digital to Analog Converter
ADC	-	Analog to Digital Converter
MOSFET	-	Metal–Oxide–Semiconductor Field-Effect Transistor

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CHAPTER 1

INTRODUCTION

1.1 PROJECT BACKGROUND

Basically the system nowadays uses fuse to protect the overvoltage or overcurrent from lightning and faults. The tick wire in the fuse leaked and breaks when the high voltage flows through the fuse. So, the loads save from the damage or broken from overvoltage. But, this fused is needed to be replacing after faults of overvoltage; this is the disadvantages of the fused because involve the maintenance cost. So, the 'PC Based SMPS Protection' is the new system design to replace the fused system that using the PC and more efficiently preventing the load form damage by automatically cut-off the power supply when system having overvoltage or overcurrent. Besides, it also can detect the unbalance voltage and current like small value of voltage to the load.

The PC based system is effective method for controlling and protecting the equipment because the pc as a main for data logging and analyzing the data. Data acquisition is the sampling to generate data that can be manipulated by a computer, data acquisition typically involves acquisition of signals and waveforms and processing the signals to obtain information to user for easily control the system that involve important load.

Some equipment that using the SMPS nowadays are SMPS for industrial robot, battery charger for mobile phone, SMPS for LCD,PDP in digital monitor, AC adaptor for personal computer and others can refer to figure 1. So, this equipment must be protected from having damage by overvoltage and overcurrent and abnormal condition. The advantage of this system is can control the SMPS with effectively

with high switching speed condition and reliable for many load or electrical equipment.

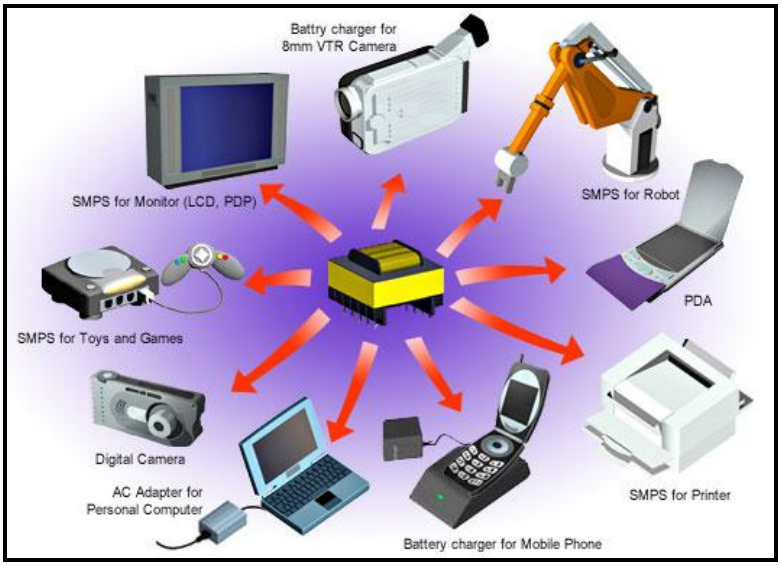

Figure 1: Some equipment using the SMPS

With the new system that can automatically controlling the the switching of smps when the are abnormal value of voltage and current occurred, so the equipment can be safe from the damage of this condition. The abnormal condition includes very low value and high value of voltage and current. Besides, the user also can monitoring the value to the load using the the PC.

A switched-mode power supply or SMPS is an electronic power supply unit that incorporates a switching regulator. While a linear regulator maintains the desired output voltage by dissipating excess power in a transistor, the SMPS rapidly switches a power transistor between full on and cutoff with a variable duty cycle whose average is the desired output voltage. So the system using the pwm signal as switching method for the system operate. The main advantage of this method is greater efficiency because the switching transistor dissipates little power in the saturated state and the off state compared to the semiconducting state. The smaller size and lighter and lower heat generation from the higher efficiency is the advantages of this system. But there has the disadvantages include greater complexity, the generation of high amplitude and filter must block to avoid electromagnetic interference (EMI), and a ripple voltage at the switching frequency and the harmonic frequencies [9].

1.2 OBJECTIVES

1. To design the system using PC that protects electrical instrument and components from having overvoltage, overcurrent and abnormal condition of signal.
2. Easily monitoring and controlling the overvoltage protection to the load using PC.

1.3 PROBLEM STATEMENT

The project focuses on designing the system that can improve of protection of overvoltage and overcurrent to load that using the SMPS. The problem is less protection to the load because just using the fuse and old equipment to protect the load from damage. This also can be harmless the load because it can't detects the unexpected value that supply to the load for example small value or less value of voltage and current. The others problem is the protection hardware are too sensitive like fuse, micro-controller and others. The sensitive element must be reduce and eliminate from system because it can influence other component. This hardware must be replacing or upgraded after uses for a long time or after having breakdown. Besides, the company that using the old system also comprise with the maintenance cost that high and expensive to replace. Others than that, the whole system must be replace including the SMPS, load and IC component that consist due to overload or overcurrent problem. The other problem is the user hard to monitoring and controlling the load due to lack of protection device and in small place that the load is place in small or complex position in the industrial or company that using the SMPS equipment. The user also can't determine when the problem occurs because the system can't show accurately the date and time when the problem occurs. So with this PC based SMPS protection, the major and others problem of protection can be reduce and upgraded. User also can easily controlling and monitoring the SMPS.

1.4 SCOPE OF THE PROJECT

The scope of this project includes hardware element and software elements that makes the system well function to protect the load from abnormal value of voltage and current. This project not includes the SMPS that is DC-DC converter. The SMPS just illustrate in the diagram below to show the pulse that controlling the MOSFET in the converter for the on-state and off-state condition switching condition. The scope was highlight in the figure 1.1.

For the hardware element the scope includes sensing element, amplifier circuit, protection and the DAQ 4716 USB type.

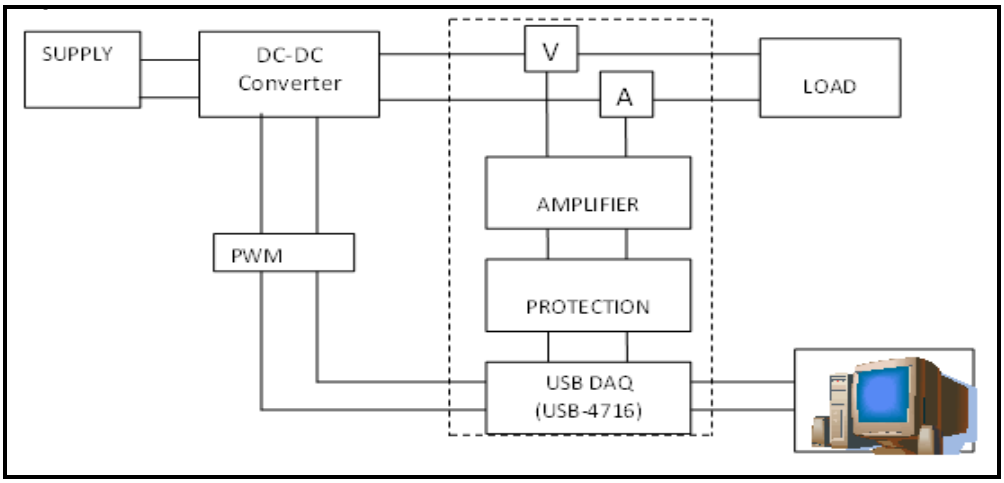

Figure 1.1: Diagram of PC based SMPS Protection System

1. The sensing element sense the voltage through the circuit for this value is taken to comparing by computer and make the GUI by the programming. This sensing element using the shunt resistor concepts that measure the voltage drop through the Rs using the small value of resistor. The voltage drop across the shunt is proportional to the current flowing through it and since its resistance is known, the calculation can be made by the programming to directly read the current value and show in the GUI.

2. Due to the small value of voltage drop across the Rs the voltage needs to be relevance to sense by the DAQ hardware to make the programming. This voltage signal need to amplifier to increase the voltage signal by the specified gain. The gain of an amplifier is the ratio of output to input power or amplitude, and is usually measured in decibels. This project using the gain factor is equal to 2, so the small value is multiple by this ratio and make the voltage available for the analysis.

3. The protection device is important to protect the DAQ hardware from the unstable voltage from the supply. For this project, the system using the zener diode as a protection device to protect the DAQ hardware from the unstable voltage.

4. DAQ (Data Acquisition) is simply the process of bringing a real-world signal, such as voltage, into the computer, for processing, analysis, storage or other data manipulation. The system uses the DAQ-4716 as the converter from the analog signal to the digital signal. This device also as a important part of this system because it can generate the PWM and make this hardware as a switching device to control the switching state of the SMPS.
5. The software includes visual basic (VB.net) and active-DAQ pro for the GUI.

1.5 SYSTEM OVERVIEW

From the figure 1.2, the flow of this project can be is explain according to step that shown. First of all, user defines the power of the equipment according to the power of the electrical component use like the motor, lamp and others that using the SMPS. After that, the user can set up the program in the pc for the voltage limit. The GUI system has set the load limit and user just select according to the load specification. The protection system running and the value is show in the GUI. The voltage drops then sense by the sensing element using shunt method with the load of the system. The small value of the voltage drop is amplified by the amplifier circuit to be sense and analyze by the DAQ USB-4716. The DAQ as a part of hardware convert the value to the digital then send the data to the pc to be analyze and stored in the memory. After that, if the value sense is normal according to the load needed, the DAQ will enable PWM signal to the converter or driver circuit that operated as a switch to make the SMPS in on-state condition and give to the load. In the other hand, if the value of the voltage detected is exceed the voltage and current or abnormal value detect, DAQ will disable the PWM signal to the converter because the overvoltage or overcurrent was occurred to the load. The warning signal and alarm also activated after the system detects the abnormal value to warn the user due to this condition happen.

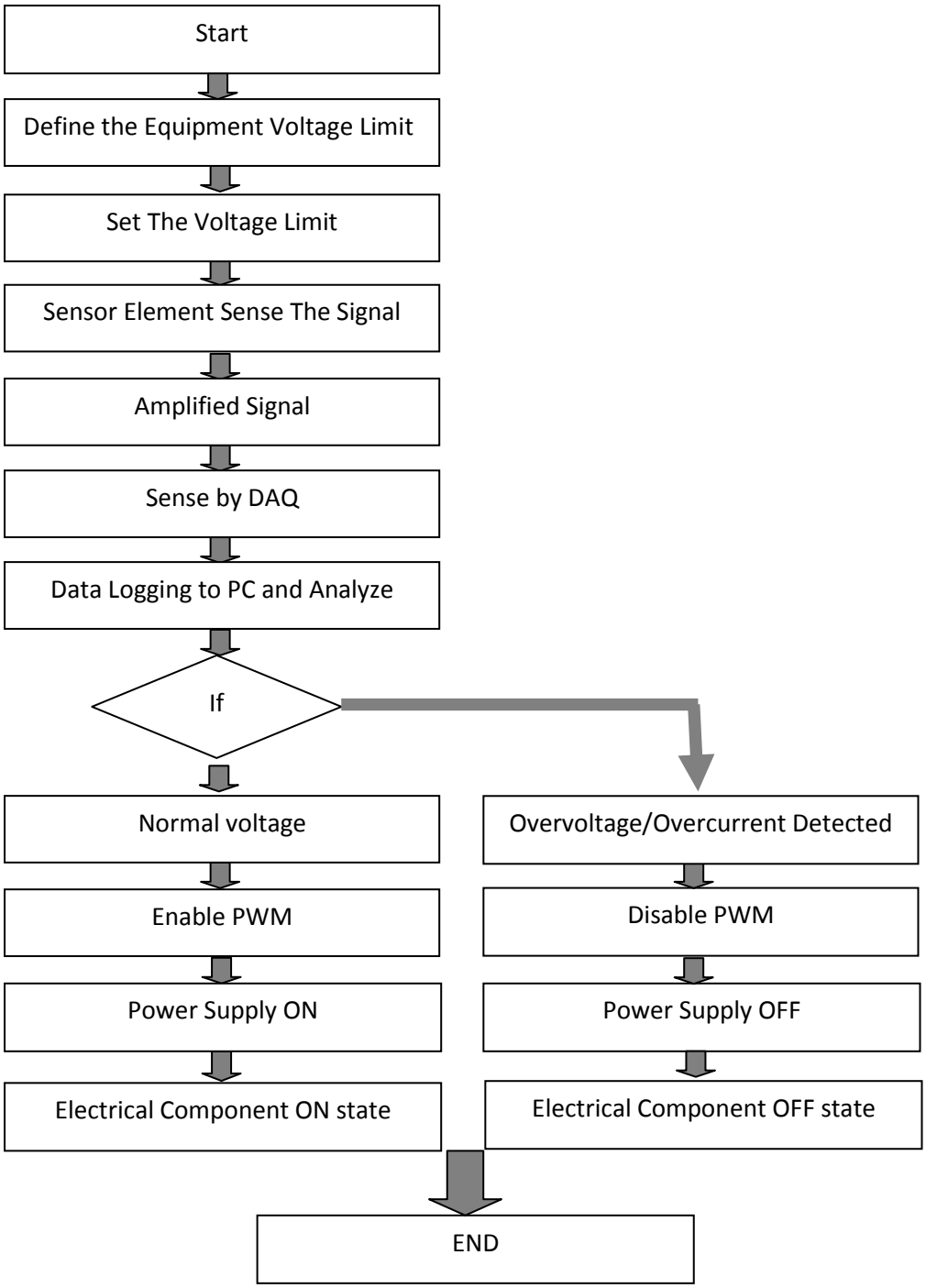

Figure 1.2: System Overview

1.6 LITERATURE REVIEW

'A computer-based voltage control experiment for advanced power system operation' [1] is the one research that using the PC to make analysis and study about the power system component. This concepts offer a cost-effective solution to the problem of expensive conventional hardware. The programmed provides a better understanding of voltage control in power system operation without the need to perform hardware experiments which are time intense and expensive to set up. Related to my system that using the PC for controlling the voltage also can make the system become more reliability because it easily to manage and controlling the data. PC as a based make the system easily organized and control.

Another project is the 'Remote Data Acquisition Systems' based with the sensor system for the variable parameter to detect the weather [2]. The project has investigated a remote weather data acquisition system, which is low cost, user configurable, and has a generic framework to support extensibility. The data is moved from the remote station to a server that stores and analyzes this data. Comparing to my project, the data of voltage and current from the circuit also analyze in the pc and make the comparison with the memory system in the data acquisition. My system can be upgraded with the transferring the data to a server that a more effective but there is not my scope on this project design.

From the another project that using PC based, it measuring the static, DC current-voltage relation related with an random 2-lead electronic device [3] A 1.0 Ohm shunt resistor is inserted in series with the 2-lead device, for the purpose of measuring the current. By measure the voltage drop across the 1.0 Ohm resistor, and then use Ohm's Law (I = V/R) to obtain the current flowing through the 1.0 Ohm resistor, which is also the current flowing through the device, since they are in series with each other. This makes the dc current sensor as related to my project to sense the current flowing through the load of the system. After the sensing elements, it must be amplified because the small value of voltage drops inflexible to detect by DAQ to access by the pc memory.

‘A PC Based Energy Management System’ provides a user the ability to differentiate between and limit the use of major power consuming appliances, allowing them to save energy. It consists of a network of ‘Smart Plugs’ that measure and control the power consumed by single phase appliances [4]. The Smart Plug is wirelessly connected to a PC which provides the user with a web-based application to remotely monitor and control their household power consumption.

From the review on the Wikipedia, I discover about data acquisition system to make this system to be good research. The DAQ is a device designed to measure and logs some parameters. The purpose of the data acquisition system is generally the analysis of the logged data and the improvement of the object of measurements. The data acquisition system is normally electronics based, and it is made of hardware and software [5]. For the example, by using Data logging, carried out by a data acquisition system, it can be used to measure parameters such as voltage and temperature in storage facilities; the measurement data are then stored for analysis to improve the system. Typically, DAQ plug-in boards are general-purpose data acquisition instruments that are well suited for measuring voltage signals. From this project, the DAQ 4716 usb type choose because it flexible and more advance in measuring the real world data to convert to the digital signal for the analysis.

‘A portable data acquisition system for the measurement of impact attenuation of playground surfacing’ [6] is a review from the other research that make by David Eager and Chris Chapman from the overseas. The objective of this project is focus on the safety of the children that influence in the place and the risk management with using the portable data acquisition as hardware for reducing the risk and testing of playground undersurfacing to restricted to the laboratory. There are many reasons why both the frequency and severity of playground injuries are not reducing. Firstly, in many cases a very large number of playgrounds do not comply with the existing undersurfacing safety Standard. So, this research scope is to reducing the injuries. Compare to my project, the as the same for safety environment to protect the electrical equipment from damage by using the portable data acquisition. From their research, I can manage and know about the data acquisition problem and the suitable condition to use it. This kind of research can helps to build understanding the new field of study and to make a new system that can helps people from the problems that occurs nowadays.

The design and construction of a high-speed data acquisition system interfaced to a personal computer is another review from other resource of the research of ‘Building a High-Speed Data Acquisition System for Spectroscopy and Other Applications’ [7]. This research has involved experience with high-speed electronics architecture, chip manufactures and their products, circuit board design and fabrication, circuit board construction and testing, microprocessor programming, and front-end software programming. This paper deals with the specific issues that arose while trying to adhere to our architectural goals and to bring this system from the early conceptual stages to a functioning viable product.

With this research, the analysis and discussion can be made about the data transfer and comparing to this project for the future upgrade to make the system well design and very reliable to commercialize. The manipulating data analysis taken from the sensing element to detect by DAQ is not much stable and effective. With upgrade the system, this project will be more reliable for data transfer because with the using of high speed construction device.